DOCUMENT RESUME

ED 050 927	24	RE 003 669

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TITLE	The Perceptual Basis of Developing Reading Skill. Final Report.
INSTITUTION	Purdue Univ., Lafayette, Ind. Dept. of Psychology.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Bureau of Research.
BUREAU NO	BR-9-E-044
PUB DATE	25 Jun 70
GRANT	OEG-5-9-245044-0035(010)
NOTE	24p.
EDRS PRICE	EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS	Complexity Level, Discrimination Learning, Early Childhood, *Infants, *Perceptual Development, Reading Development, Sensory Training, *Stimulation, *Visual Discrimination, *Visual Perception, Visual Stimuli

ABSTRACT

Four studies with infants and preschool-age children examined various pattern perception tasks considered to be related to the perceptual basis of the development of reading skills. Study 1 used 28 neonates to test the hypothesis that supplemental stimulation (rocking, patting, holding) has measurable effects upon attention to visual patterns. Results supported the hypothesis. Study 2 used 24 neonates to test the hypothesis that kinesthetic stimulation (rocking) effects attention to visual patterns. Results showed no significant effects of supplemental stimulation upon visual attention; however, there was a significant effect of target complexity upon attention. Study 3 used 32 3- and 4-year-olds to test the hypothesis that preference for complexity of stimuli increases with age. Results confirmed the hypothesis, but there was also evidence that children were not responding solely to stimuli complexity. Results of Study 4 with 10 3- and 4-year-olds showed that (1) mirror-image reversal discrimination is difficult, and subjects were sensitive to complexity differences and (2) data were ambiguous in regard to whether children process multivariate stimuli differences simultaneously. Tables and references are included. (VJ)

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Final Report

Project No. 9-E-044

Grant No. OEG-5-9-245044-0035(010)

THE PERCEPTUAL BASIS OF DEVELOPING READING SKILL

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June 25, 1970

U. S. DEPARTMENT OF
HEALTH, EDUCATION AND WELFARE

Office of Education
Bureau of Research

Final Report

OE Bureau of Research No., Contract or Grant No. OEG-5-9-245044-0035(010)

Period: January 1, 1969 to June 30, 1970 Date of Submission: 25 June 1970

Name of Institution: Purdue University

Title of Project: The Perceptual Basis of Developing Reading Skill

Name of Project Directors: Donald R. Brown
Donald R. Ottinger

Contents

General Introduction

The research completed under the auspices of this grant included four completed studies, two with infants and two with preschool-age children. The combined purpose of the studies was to examine various pattern perception tasks considered to be related to the perceptual basis of the development of reading skill.

This report is organized around those four studies taken individually.

Infant Studies

Introduction

The two studies completed with infants were concerned with attention to patterned stimulation and with the effects of stimulation upon attention.

Study 1. Neonate Attentiveness to Pattern

Both developmental theory and animal research suggest that specific early experiences have enduring effects upon the intellectual and emotional development of a variety of kinds of animals (Hunt, 1961; Der-nberg, 1966). Moreover, it has been repeatedly demonstrated (e.g., Fantz, 1965) that very young infants are selectively attentive to patterned vision. Accordingly, this study was designed to examine visual attention to patterns as a function of the extent to which supplemental stimulation was provided to neonates during the first four days of life.

Method

Subjects. Subjects were 28 full-term neonates, thirteen male and fifteen female, who were born in a general hospital.

Experimental Design. Subjects were randomly assigned to a control and an experimental group with sex controlled. There were six experimental males, seven control males, eight experimental females, and seven control females.

Procedure. Within 12-30 hours of birth all neonates were tested for visual attentiveness to a series of patterns. The twelve-hour minimum was imposed to reduce the effects of medication upon the infants behavior (Brazelton, 1961; Stechler, 1964). Patterns selected for study consisted of either 1, 3, or 5 black dots presented on a white background. These patterns were assumed to represent a complexity scale defined in terms of the number of light-dark stimulus transitions (Hershenson, Munsinger, & Kessen, 1965).

Infants were tested in a modification of Fantz' (1958) apparatus. Essentially, this consisted of presenting targets in a display board. With the infant held 19 cm. from the targets, fixation was measured by corneal reflection viewed through a screen over the targets.

Babies were tested approximately one-half hour before feeding in the morning. The six pairs of the three patterns were presented in a random order. Total fixation time on each target was measured with a hand-operated millisecond timer.

Following the pretest measurement of fixation, all experimental neonates were given supplemental stimulation which consisted of:

Procedure for Supplementary Experience

As soon as the pre-testing was completed, infants in the experimental groups were exposed to several types of stimulation.

1. They were held at the shoulder of E, again at a distance of 19 cm., and shown, for a period of 5 minutes, an electric color wheel having different colors and shapes, and rotating slowly (10 rpm).

2. They were placed on the lap of E and had their backs gently rubbed for ten minutes.

3. Again while being held to the shoulder of E, they were exposed for five minutes to a flat circle on which a schematic face was painted. This rotated continually (30 rpm) around a brightly painted semi-sphere, thus passing in and out of Ss field of vision.

4. They were exposed to five minutes of 'mother talk" while being rocked and held by E. This kind of auditory experience was chosen in preference to a more controlled stimulus, such as a record, in order to provide more personal contact and greater contrast to the background music often present in the nursery.

5. They received 15 minutes of rocking with an electric crib rocker, hung from the side of the crib. This apparatus ("Mr. Sandman", manufactured by the Niagara Corporation), operated on medium speed, provided a jiggly motion which appeared to be well tolerated by all Ss.

This 25 minute procedure, exclusive of the rocker, was carried out twice a day, morning and late afternoon, almost always before feeding, for three days. Occasionally, the baby would seem especially hungry and would be fed early, so that the experimental experience followed the feeding. Since any loss of visual experience by a satiated and sleepy baby would possibly lessen the fixation times on the post-test rather than increase them, the data from these Ss were included in the study.

The automatic rocker was employed for 15 minutes, six times a day, at approximately every four hours. Two of these times were in conjunction with the twice daily supplementary experience sessions. Sometimes the rocker was used before feedings, and sometimes after, at the convenience of the mother and of the nursing staff.

Totaling all forms of stimulation, there were 140 minutes a day of supplementary experience, for three days, given to all experimental Ss.

In addition, a plastic mobile at the head of the crib, a pinwheel at the side, and abstract designs as crib liners served as visual stimuli within the crib. Control babies received only routine stimulation.

On the fourth day after birth, all babies were retested for visual fixation.

Results

An unweighted means analysis of variance was used to analyze total time the neonates' eyes were open during testing and the proportion of this time which was on target.

The mean total time eyes were open is given in Table 1 for all conditions. An analysis of variance of these data showed a significant pre-post main effect ($p \leq .01$) but no other effects (sex, experimental condition) or their interactions were significant. Not surprisingly all subjects were, therefore, more alert when they were older!

Proportion of fixation time on Target is summarized in Table 2. An analysis of variance of the arcsin transformation of these data showed only a significant interaction between the experimental-control and pre-post test variables ($p < .01$). Experimental babies on the post-test fixated longer than controls with no significant difference in pretest.

Finally, an analysis was completed to evaluate preference for levels of complexity. The mean total viewing time for the most and least complex of each pattern pair is summarized in Table 3.

A t statistic showed no significant difference between least and most complex during pretest ($t=1.39$), but a significant difference was demonstrated at post-test ($t = 2.32$, $p \leq .05$).

Table 1. Total Time Eyes Open: Mean Scores in Seconds

Group	N	Pre-Test	Post-Test
Exp. Male	6	102.3983	127.8850
Exp. Female	8	116.8738	136.8338
Control Male	7	108.6128	124.0457
Control Female	7	105.7386	126.9286

Table 2. Total Time Eyes on Targets: As a Proportion of Total Time Eyes Open - Mean Scores.

Group	N	Pre-Test	Post-Test
Exp. Male	6	.5016	.5896
Exp. Female	8	.5581	.7249
Control Male	7	.5651	.5064
Control Female	7	.5861	.5803

Table 3. Preference for the More Complex and the Less Complex of Each Presentation: Mean Total Scores in Seconds.

Test	Less Complex	More Complex
Pre-Test	26.8639	34.0110
Post-test	30.6103	48.7303

Discussion

The hypothesis under study was that supplemental experience administered to normal neonates has measurable effects upon attention to visual pattern.

This hypothesis was supported and the results are in accord with previous findings that older infants are more attentive following extra handling (White & Castle, 1964) and the literature which demonstrates selective attention to patterns at an early age.

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Study 2. Neonate Cognitive Development: The Effect of Kinesthetic Stimulation Upon Attention.

In view of the outcome of the first study, a second study was designed to evaluate the effects of supplemental stimulation more specifically. In particular, the complex nature of the extra stimulation provided the experimental neonates in the first study was simplified in an effort to begin to isolate the effects upon visual attention to patterns.

Method

Subjects. Twenty four full-term neonates, 12 male and 12 female, were tested. All subjects were caucasian, were apparently normal, and were born in a general hospital. All were normal deliveries and breast-fed and bottle-fed babies were assigned randomly to conditions.

Apparatus and Procedure

Babies were assigned randomly by sex to one of two experimental groups and to a control group. Experimental subjects received either 25 or 50 minutes of crib rocking after each feeding during the first three days of life. Crib rockers (Mr. Sandman by Niagara Corporation) were electrically powered machines which attach to the crib. The control babies received only normal hospital and maternal stimulation.

Testing was completed on the third or fourth postpartum day at which time the age ranged from 64 - 96 hours.

The visual attention test was the same as that used in the first study except targets were presented singly, five targets with from one to five dots were used, and each target was presented twice in a random sequence. Each target was presented for 30 sec.; total time the eyes were open, total fixation time on the target, and the number of fixations were all recorded.

Results

An analysis of variance of total fixation time on targets showed no effect due to sex or stimulation conditions, but there was a highly significant complexity effect ($F = 7.77$, $df = 4,72$, $p \leq .0001$) with preference for (fixation longer) more complex patterns. This was found to be due to the difference between the simplest pattern (1 dot) vs all other patterns (2,3,4 or 5 dots) with no difference among the more complex patterns.

An analysis of variance of the proportion of fixation time to total eyes-open time (transformed to arc-sin). The results of this analysis were identical to those for total fixation time.

An additional analysis of mean fixation time was computed to reflect the fact that different numbers of fixations occurred. An analysis of variance yielded differences identical to those of the first two analyses.

A final analysis of variance was computed using total eyes-open time. No significant effects were observed.

Discussion

These data were consistent with those of the first study in showing a significant effect of target complexity upon attention. In contrast, no effects of supplemental stimulation upon visual attention were observed.

Pre-School Age Studies

Introduction

Two studies were completed in which pre-school age children served as subjects. The purposes of these studies were both methodological and substantive. From a methodological point of view, our concern was with developing sensitive techniques to assess performance. From a substantive point of view, the first paper was concerned with attention to pattern attributes, and the second was concerned with multivariate information processing.

Study 1. A Developmental Study of Preschool Children's Preference for Random Forms[1]

A number of studies have investigated the development of preferences for visual stimuli varying in complexity defined in terms of the number of sides in randomly generated polygons. There is some evidence (Munsinger, Kessen, & Kessen, 1964; Thomas, 1966; Wohlwill, 1968) that when stated preference for one member of a pair of random polygons serves as the measure of preference, college students prefer intermediate levels of complexity, while 6- and 7-year-olds prefer the most complex stimuli. With pre ol age children, Munsinger and Weir (1967) used viewing time as the measure of preference and obtained an increasing monotonic function relating preference to complexity. However, Kaess and Weir (1968) found that for 3-, 4-, and 5-year-olds there were no differences in stated preference associated with age. The purpose of the present study was to provide further data on the stated preference of preschool children for random forms.

[1]This paper is being written for publication with K. N. Black and T. M. Williams.

Method

Design

The experiment was designed to provide cross-sectional and longitudinal data about the stated preferences of 3- and 4-year-olds for visual complexity as determined by sidedness.

The younger group was composed of ten girls and eight boys, with a median age of 3 years, 10 months. The older group included eight girls and six boys with a median age of 4 years, 9 months. With the exception of one Thai boy who was fluent in English, all of the subjects were white Caucasian. All were the children of either professors or students.

The stimuli were black random polygons each containing 4, 8, 12, 16, or 20 sides. Each polygon was on a separate, white, 3-1/2 inch by 6-inch card. Four stimuli at each of the five levels of complexity made up four different, but comparable, sets of stimuli. The stimuli and complexity values are described in more detail elsewhere (Brown & Owen, 1967; Brown & Brumaghim, 1968; Brumaghim & Brown, 1968).

Each child was presented with all ten possible pairings of one of four sets of five random polygons, with order of pair presentation within each set randomly assigned for each child, and each form appearing equally often on the left and right sides.

One year later nine children, with a median age of 4 years, 8 months, from the original group of 18 younger children who were still enrolled in the nursery school stated their preferences for the same ten stimulus pairs they had seen previously.

Procedure

To familiarize _S_ with the task, E first presented three pairs of sample stimuli. Placing one of the first pair of sample stimuli in front of _S_,

E said, "Look at this picture," and, placing the other stimulus of the pair beside it, said, "and now look at this one." E continued, "Which one would you like to see again?" When the child had indicated his choice, E removed both stimuli, and placed the chosen stimulus on the table, and said, "You may look at it as long as you wish. Tell me when you have finished." When S indicated that he no longer wanted to see the stimulus, E removed the form, and recorded S's choice. Following the third sample pair, E placed the five stimuli of the experimental set in a row on the table in front of S saying, "Now we are going to do it with these pictures. Have a good look at them." After about 10 seconds, E removed the five stimuli and the experimental trials began immediately.

Results

The curves relating stated preference to level of complexity are shown in Figure 1. In order to evaluate the extent to which age differences were reflected in the data shown in Figure 1, an analysis of variance of the within-subject variance of the transformed (arc sine) percentage of choices of the 3- and 4- year old children was computed. Since the Complexity X Age Groups interaction was significant ($F_{4,120} = 4.75$, $p < .01$),

Insert Figure 1 about here

the curves relating stated preference to level of complexity may be considered to be different for the two age groups. It is clear from Figure 1 that this difference is due to greater preference for less complex patterns by the younger children and greater preference for more complex patterns by older children. The form most preferred by the younger children was the 8-sided polygon, while the 12-sided polygon was most preferred by the older children.

When the data are compared for the children who were tested both at 3 and 4 years of age on the same pairs of patterns (RPM Ss), it is clear that a shift in preference occurred toward the more complex patterns. A Sign test was used to evaluate the frequency with which Ss chose more complex stimuli more frequently than previously. Eight of the nine children performed in this manner ($p < .02$).

Discussion

The tendency for 4-year-olds to prefer the more complex stimuli and for 3-year-olds to prefer the less complex stimuli is consistent with previous findings indicating that preference for complexity increases with age. That the 8-turn shape was most preferred by the younger group and the 12-turn shape was most preferred by the older group is remarkably close to the Munsinger, Kessen, and Kessen (1964) finding of a general preference for 10-sided polygons. The data involving measures a year apart reinforced the conclusion that the preferences of 3- and 4-year-old children are significantly different. These results contradict the lack of preference for complexity differences as a function of age among preschool children found by Kaess and Weir (1968). However, the shape of the function relating preference to level of complexity in the present study was not remarkably unlike the curve obtained for stated preferences by Kaess and Weir (1968). If the curves for the younger and older groups shown in Figure 1 were combined, the resulting curved would be very similar to the one reported by them for their combined data on 3-, 4-, and 4-year-olds.

It is likely that the children's preferences were multidimensionally determined. During the data collection, E observed that some of the

children attributed meaning to particular forms, indicating that they were not responding to complexity alone. In addition, there was some evidence that the children were responding to novely, despite E's attempt to eliminate it by having S look at all of the stimuli before the paired comparisons were made.

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Study 2 Multivariate Stimulus Discrimination by Preschool Children[1]

Introduction

It has been previously demonstrated (Gibson, Gibson, Pick, & Osser, 1962) that children below eight years of age have difficulty discriminating among patterns containing mirror-image reversals. It has also been demonstrated in a variety of discrimination and preference tasks that children of this same age range are sensitive to pattern complexity (e.g., Brown & Goldstein, 1967). Accordingly, in this study, discrimination was studied for patterns which varied in both these respects to assess the extent to which preschool children simultaneously process multivariate sources of information.

Method

Subjects

Ten nursery school children, age 3-4 1/2 years, served as subjects.

Problems

Eight patterns, shown in Figure 1, were generating by combining four levels of complexity with left-right mirror images. Twenty eight, three-choice oddity problems were created as the $\binom{8}{2}$ pairs of patterns (Set A). In each problem, one pattern was randomly selected and reproduced as the third pattern; the other pattern became the "correct" or "different" pattern in the three-choice problem with the position of the correct pattern randomly selected. Another set of twenty eight problems was generated in which the previously - incorrect pattern became the odd pattern of the pair (Set B).

[1]Study 2 was presented at the University of New Hampshire Psycholgocial Conference, April 25, 1970 under the authorship of L. Harrington & D. R. Brown.

Apparatus & Procedure

Ten 4-year old subjects were tested individually in 1-hour sessions in which the twenty eight patterns of Set A or Set B were presented in an independent random sequence for each subject. The order of Sets A and B was counterbalanced over groups of 5 subjects.

Subjects were instructed to find the different pattern in each problem. For each trial, the patterns were presented on 2 x 6" cards in the window of a wooden frame. When E raised a guillotine door, the patterns were exposed and a millisecond timer was started. The timer was connected to 3 push-buttons located immediately below the door and it stopped when the subject indicated his choice by pushing one of the buttons. Both discrimination latency and errors were recorded. No feedback was given.

Results

The major results are shown in Table 1 where mean latencies are shown for the two sets of problems, for the two groups of subjects, and for groups of problems based upon the type of information available for discrimination. For this latter classification, within each set of twenty eight patterns, problems were classified on the basis that the patterns differed only in having a reversal but no complexity difference (R), having a complexity difference but no reversal difference (C), and having both a complexity and a reversal difference (CR). There were 4, 12, and 12 patterns in each of these classes, respectively, for both Set A and Set B.

An analysis of variance of these data showed a significant three-way interaction between problem sets, groups, and the classification. Since group differences were equivalent to sequence effects for sets of problems

Table 1

Mean Latencies for Experimental Conditons

	Set A Conditions			Set B Conditions		
	R	C	C & R	R	C	C & R
Group 1	20.87	17.81	19.90	17.37	14.65	15.56
Group 2	27.62	23.47	23.75	16.87	14.97	15.74
Means:	24.28	20.64	21.82	17.12	14.81	15.65

(AL vs BA) this interaction reflects the fact that Set A problems were relatively more difficult for Group 2 subjects who saw them first in the sequence. The other major finding was a significant effect due to problem classes. In particular, it is obvious that problems in which the only basis for discrimination was a mirror image reversal were more difficult to discriminate. When a complexity difference was present (C & CR) problems were equally difficult.

Discussion

The data support previous results in showing that discrimination on the basis of mirror-image reversals is difficult and that subjects of this age are sensitive to complexity differences, since complexity differences led to shorter latencies. The data are ambiguous with regard to whether children process multivariate stimulus differences. If subjects were sensitive to the presence of complexity differences in the presence of a reversal, one might predict that latency would increase. That is, the reversal would make discrimination more difficult. Alternatively, one might argue that the latency would be the same as for the C condition since observers could ignore the reversal and attend to the complexity difference. Apparently this is what occurred.

With the advent of nonmetric multidimensional scaling techniques (Kruskal, 1964a, b) which assume only a monotonic relation between distance in a spatial configuration and some analogue to perceived similarity, latencies should be amenable to a spatial analysis. This has been successfully carried out with adults (Brown & Andrews, 1968). Such an analysis would yield a spatial configuration corresponding to the extent to which discrimination is related to the separate stimulus attributes.